Advanced Packaging

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Agenda

- Requirements/Goals
- Current Europa Slice Arrangement
- Current Europa Baseline Chassis
- X-2000 CPCI Slices-Example
- Chassis Thermal Analysis
- Chassis Structural Analysis
- Slice Thermal Analysis
- Slice Structural Analysis
- Connectors Validation Test Status
- Others Status
- Issues and Concerns

Requirements/Goals

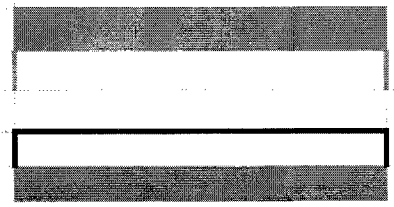
- Major Requirements
  - Mass - Targeting 100 Kg for Avionics system with radiation shielding
  - 10 Mrad behind 1mm [40 mil] spacecraft structure with 1.5 RDM radiation shielding.
  - 0.2 g^2/Hz vibration at slice and at the interface of the panel and chassis.
  - 2000g Pyro shock at the interface of the panel and chassis.
  - -55° C to +70° C operation at slice interface.
  - Any X-2000 slice must be able to insert into a standard compact PCI chassis.
  - Must be able to remove any slice without affecting other slices.
  - Must handle up to 12 Watts heat dissipation on any given Slice.
- Goals have been established such as:
  - Industry available connectors, cables and breakout boxes.
  - Standard mounting hardware.
  - Power dissipation handling capability independent of card position in chassis.
  - Backplane removal without affecting other cards or backplanes.
  - Fit 16 Power Switches on a Slice.
  - Slice to Slice interconnect through backplanes.
  - Key Slice by Slice Type.

Europa Orbiter/X2000 Avionics Industry Briefing

Current Europa Slice Arrangement

	Chassis 1 CDH / ACS		Chassis 2 Power	
1	PCAS3-CDH-A/1394A	PCAS5-I2C-0A/B	PCAS1-PSE-A	PCAS2-PSE-B
2	TIF-A		PCAS6-I2C-1A/B	PCS-1
3	SIA-A2			PCS-2
4	SIA-A1			PCS-3
5	SIO-A			PSS-PD3
6			PCAS7-THR	PSS-PD4
7			PSS-VDE1	PSS-PD5
8		RWE1-1	PSS-VDE2	PSS-PD6
9	SFC-A	RWE2-1	PSS-VDE3	PSS-PD7
10	SFC-B		PSS-VDE4	PSS-PD8
11		RWE1-2	PSS-VDE5	PSS-PD9
12		RWE1-3	PSS-VDE6	SHIELD
13		RWE2-2	PSS-VDE7	PSS-PYRO1
14	SIO-B	RWE2-3	PSS-VDE8	PSS-PYRO2
15	SIA-B1		PSS-VDE9	PSS-PYRO3
16	SIA-B2		PSS-VDE10	PSS-PYRO4
17	TIF-B	TAS-1	PSS-PD1	PSS-PYRO5
18	PCAS4-CDH-B/1394B	TAS-2	PSS-PD2	PSS-PYRO6

Shield Slice
Memory Slice Shielding
End Cap Shields
Cabling goes to exterior of S/C
PYRO Sheild



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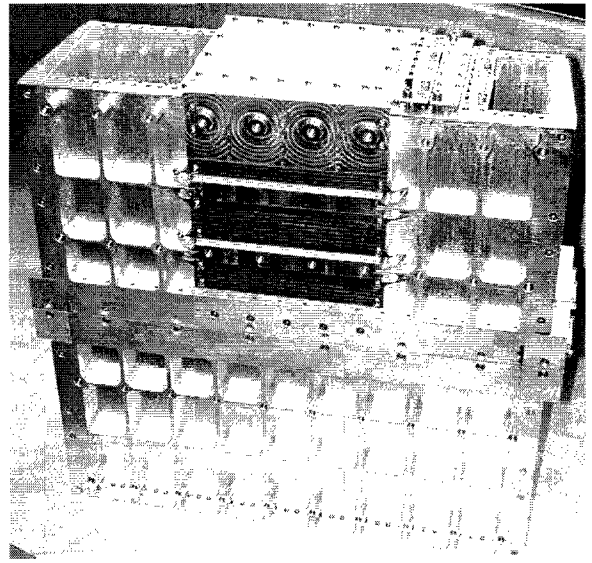
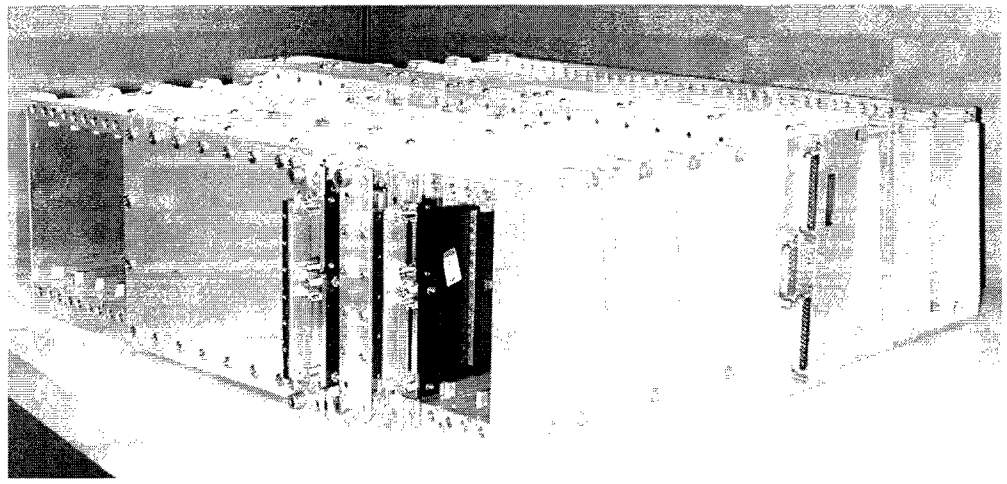
Current Europa Baseline Chassis

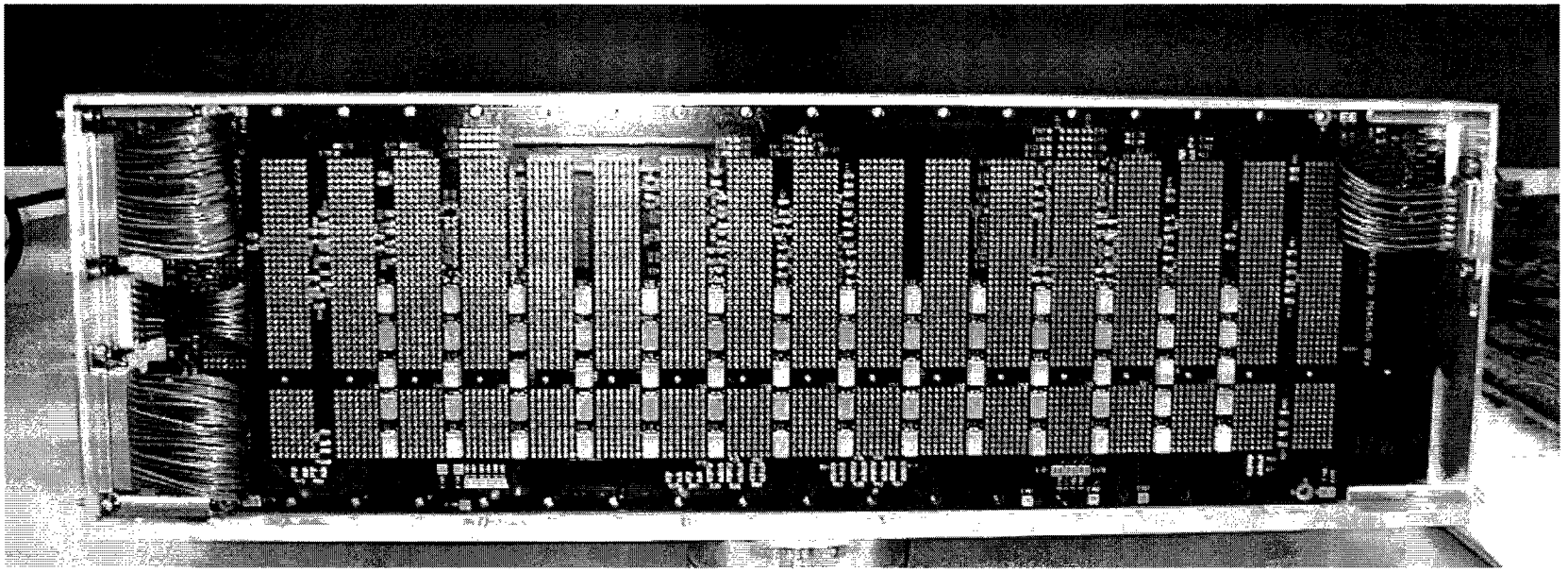
- Each Chassis mounted on separate spacecraft panel.
- Size Constraint, including cables:
  - 575mm [22.64"] to 620mm[24.41"] wide
  - 600 mm [23.62"]high
  - 152 mm [5.98"] deep.
- Chassis
  - Two rows of cards
  - Multiple Backplanes
    - **Connected using Flex Cable(s)**
- Internal Access Cabling
  - Backplanes
  - Multiple Front Panel Connectors.
- External Access Cabling
  - Multiple Side Panel Connectors.



C&DH Chassis



CDH BackPlane in EM Chassis



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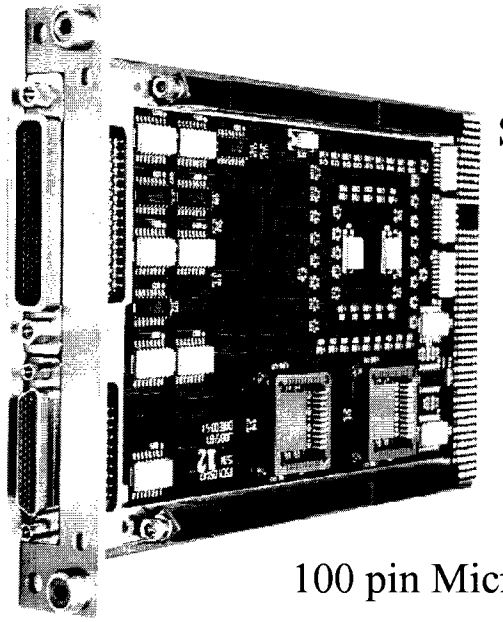
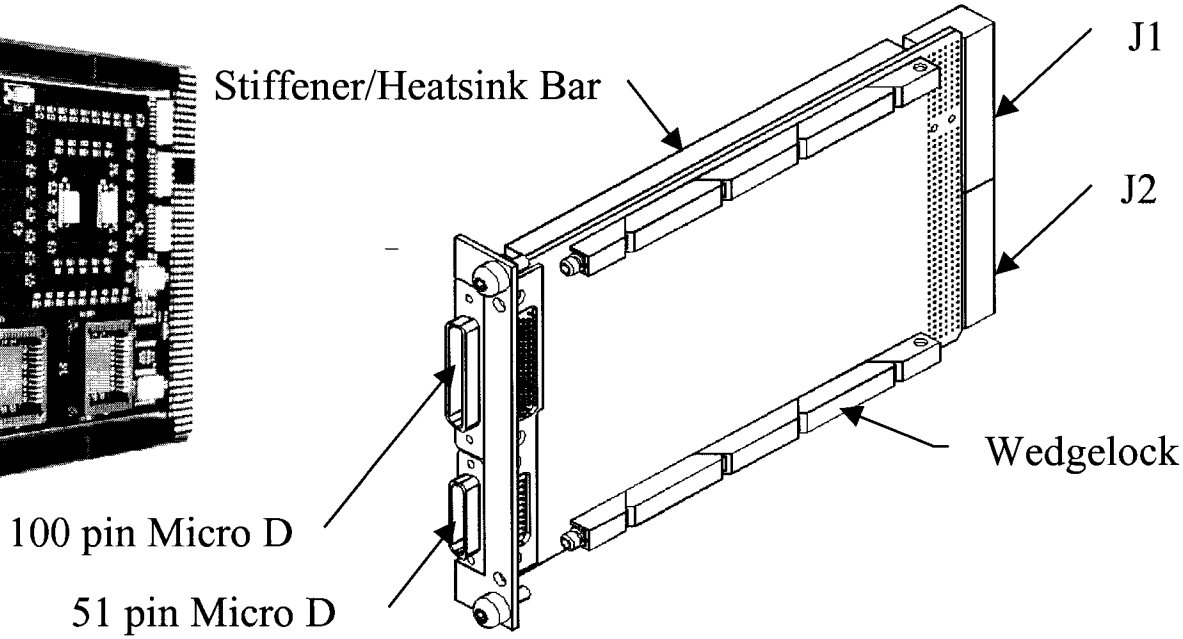
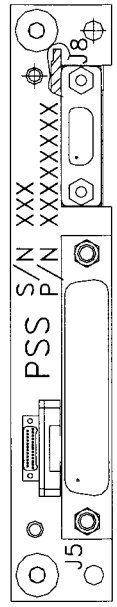
X-2000 CPCI Slice Configuration



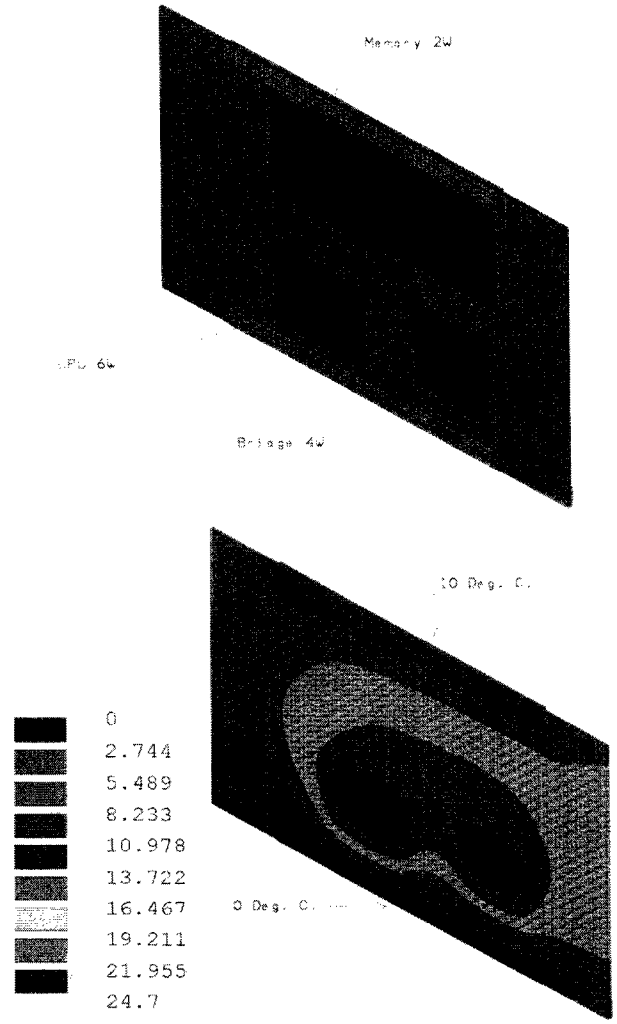




- **Circuit Areas:**
  - **-81.2 mm by 133 mm (~16.75 in²) on each side**
- **Component Height**
  - **-10.0mm (0.393 in) high on one side**
  - **-6.0mm (0.236 in) high on the other side**
- **Board Thickness of 2.0 ± .2 mm (~0.080±.008 in)**

Generic Slice Thermal Analysis

- Assumptions:
- Printed Wiring Board
  - 2mm [.080"] polyimide-glass PWB
  - Three copper planes, 0.0625mm [.0025"] thick
- Wedgelocks
  - Thermal resistance of 2.5 °C / Watt /inch
- Thermal Constraints
  - Upper rail is 10 °C higher than lower rail
  - Total maximum power Dissipation for System Flight Computer is 12 Watts (worst case card).
- Results:
  - Maximum temperature rise of approximately 25 °C referenced to the CPCI chassis lower rails.
  - Acceptable component temperatures were within reach (Tj= ~113° C; PowerPC Package: 2.2°C/Watt), given specific attention to PWB layout and mounting of hot parts.
  - Individual vendors responsible for detailed analysis.

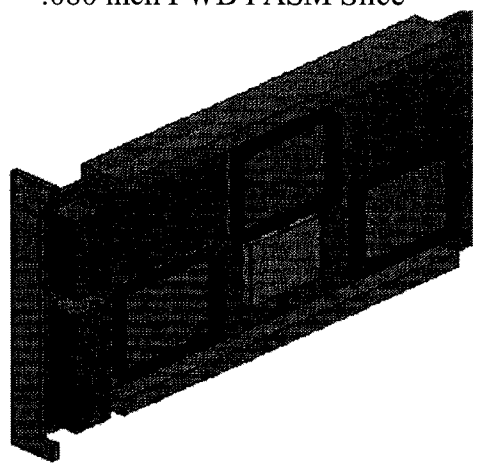


Generic Slice Structural Analysis

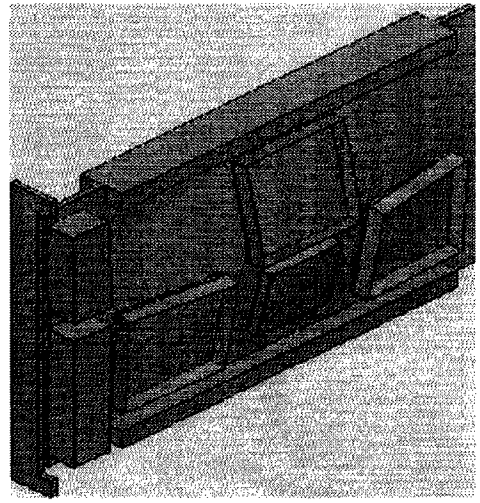
Assumptions:

- Printed Wiring Board
  - Board Thickness 2.0 mm [.080"],
  - Flexural modulus 20.67 x 106 KPa[3 x 106 psi],
  - Specific weight 2.8 g/cm3 [0.1 lb/in^3].
  - Additional component weight totaling 190g.
- Constraints:
  - Power Spectrum Density (PSD) Of 0.2 g2/Hz.
  - Q=15
  - Wedgelocks Fixed (in theory 1/4 of fixed deflection, and 1/3 of fixed deflection from deflection test result).
  - Front Panel Fixed.
  - CPCI Connectors Simply Supported.
- Results
  - 3-sigma deflections of 0.25mm [.010"] acceptable per Steinberg requirements.
  - Natural Frequency of 350 Hz.
  - Individual vendors responsible for detailed analysis.

.080 inch PWB PASM Slice



Exaggerated for Clarity



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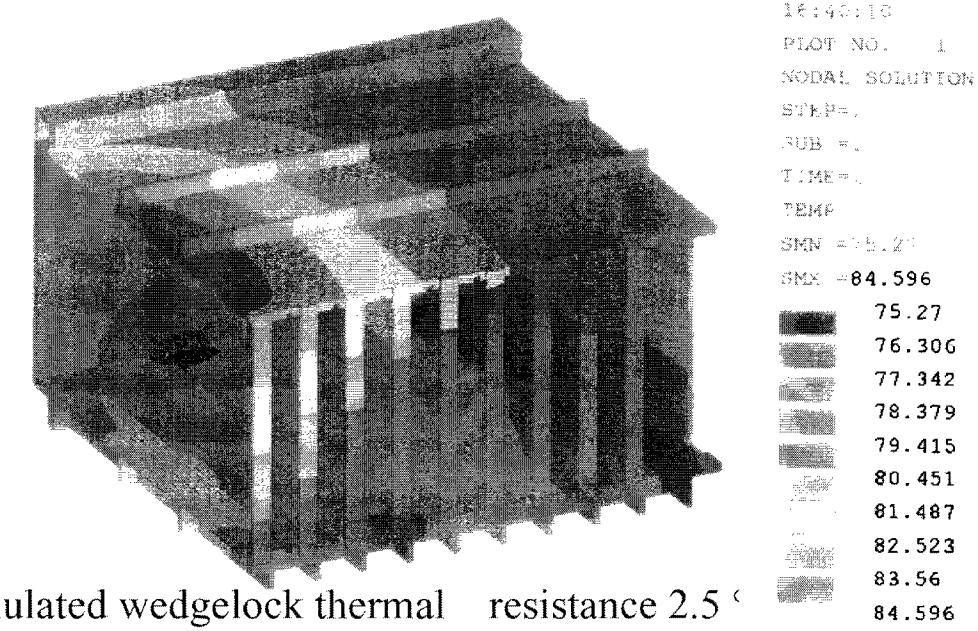
EM Chassis Thermal Analysis

Slice	Watts
SFC	**9.9**
NVM1	**3.1**
NVM2	**.8**
- Vault -	
SIO	**.88**
SIF	**.12**
RWE	**.15**



Model Detail:

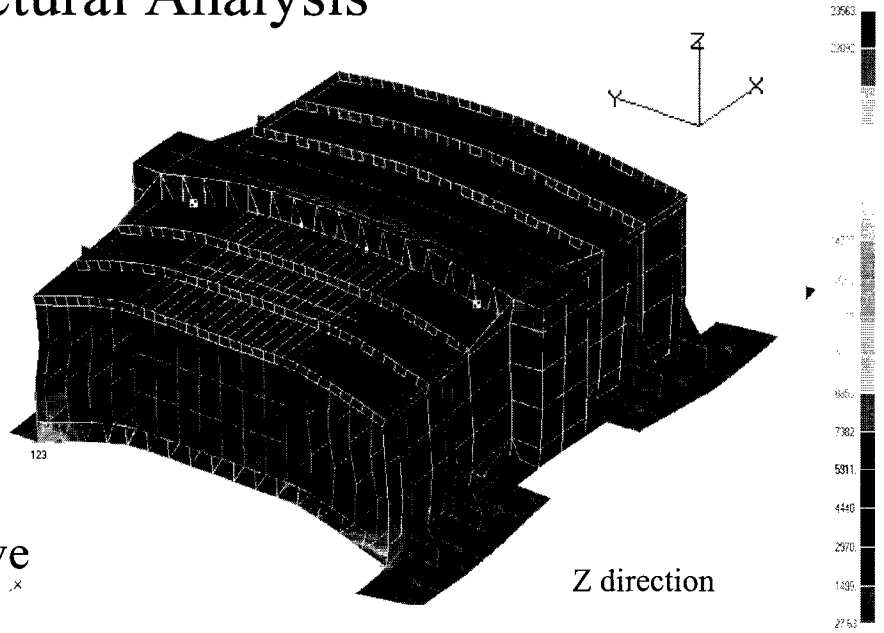
- Heat loads spread over each PWB.
- Total power dissipation of 15 W on 1/4 chassis.
- PWBs conduct heat to chassis through simulated wedgelock thermal resistance 2.5 ° Watt / inch length.
- Chassis conducts to shear plate through 5 bolted joints, thermal resistance of 1/3 °C / Watt each joint.

Results:

- PWB mounting rails temperature: bottom rails are 80 °C maximum, upper rails are 85 °C maximum, with the assumption of that steady-state temperature for chassis and spacecraft panel interface is 75 °C .

EM Chassis Structural Analysis

Mode	Frequencies	Deflections	Directions
1	125 Hz	0.475mm [0.0187"]	Y
2	146 Hz	0.348mm [0.0137"]	Z
3	177 Hz	0.237mm [0.00934"]	X



Z direction

- Model Details:
- Mass of total model is 49.43 kg (109 pounds)
- Constraints at four corners.
- Loads are Based on Mass Acceleration Curve (MAC) = 18.0 G's
  - Factor of safety of 1.25 for yield.
  - Factor of safety of 1.40 for ultimate.
- Results look at ultimate load of 30 G's:
- Highest stress occurred near attach point and was 184,886 KPa [26,834 psi].
- Corresponding Margin of Safety is +1.38.

Connector Validation Status

- Dynamic Tests: shock(2000g), vibration (.2g^2/Hz), and severe vibration (.4g2/Hz).
  - Completed showing acceptable results.
  - Report released to the IFDP library.
- Thermal Soak Test: 3000 hours at 125oC
  - 1100 hours complete. Memo written
  - 3000 hours complete. Preliminary results show no problem.
  - Test report to be written.
- Thermal Cycling Test: 200 cycles, -55°C to 125° C
  - Complete except for 1394 connector which needs to be retested.
  - Test report released.
- Current Rating Tests:
  - Completed current rating in air.
  - Current rating transient completed.
  - Current rating in vacuum underway.
  - Results show the CPCI connectors from two manufacturers met the required current carrying capability.
  - Test report released.

Miscellaneous Status

- Documentation/Drawings:
  - Released 10 Slice MICD's.
  - Released CDH/ACS EM detail chassis drawings.
  - Validation Chassis: Fabrication and Assembly drawings released to PDMS.

- Prototype Hardware
  - Delivered 7 CDH commercial chassis with custom backplanes.
  - Delivered 4 Power commercial chassis with custom backplanes.
  - Delivered Rear I/O slices for TAS, TIF, SIO,SIA, SFC, PCA, PSS.

- Dimpled BGA Qualification
  - Dynamic levels of .2 and .4 G2/Hz and 2000G shock after 10 cycles –55 to 100 C.
  - 200 cycles –55 to 100 C.

Issues and Concerns:

Concerns

- Fitting Cables for Power Switch Slices (PSS) front panel due to the goal to stay within 20.32mm [0.80"] CPCI specification.
- PCA Envelope Increase

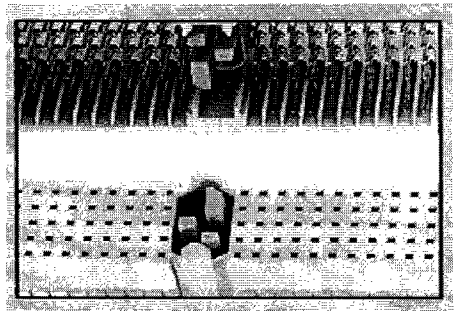
Action Plans:

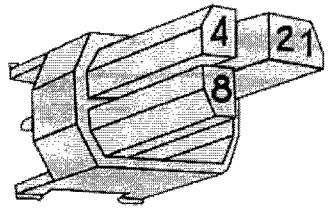
- Work the option to reduce number twisted shielded pair on the front panel. Bring some interconnect through the backplane.
- Study underway to examine impact of increasing height of slice from 10 mm to 11.65 mm.

Europa Orbiter/X2000 Avionics Industry Briefing

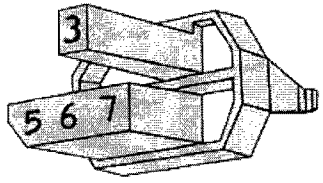
Keying

ITEM	KEY CODE		SLICE TYPES										COMMENTS
	RAL NO	COLOR	BCS	PCA	PCS	PSS	SFC	SIO	NVM	SIA	TIF	TAS	
1	2003	PASTEL ORANGE	X										
2	5011	STEEL BLUE								X			
3	7015	SLATE GRAY						X					
4	1021	CADMIUM YELLOW							X				STANDARD CPCI 3.3V
5	6011	RESEDA GREEN					X						
6	5007	BRILLIANT BLUE		X*(5V)									STANDARD CPCI 5V for **PCA 5V**
7	4005	BLUE LILAC			X								
8	1024	OCHER YELLOW										X	
9	3018	STRAWBERRY RED				X							STANDARD TELECOM (P4/J4)
10	8011	NUT BROWN		X(3.3V)									**PCA 3.3V**
11	None	Mechanical Coding									X		





Key for Male Connectors



Key for Female Connectors

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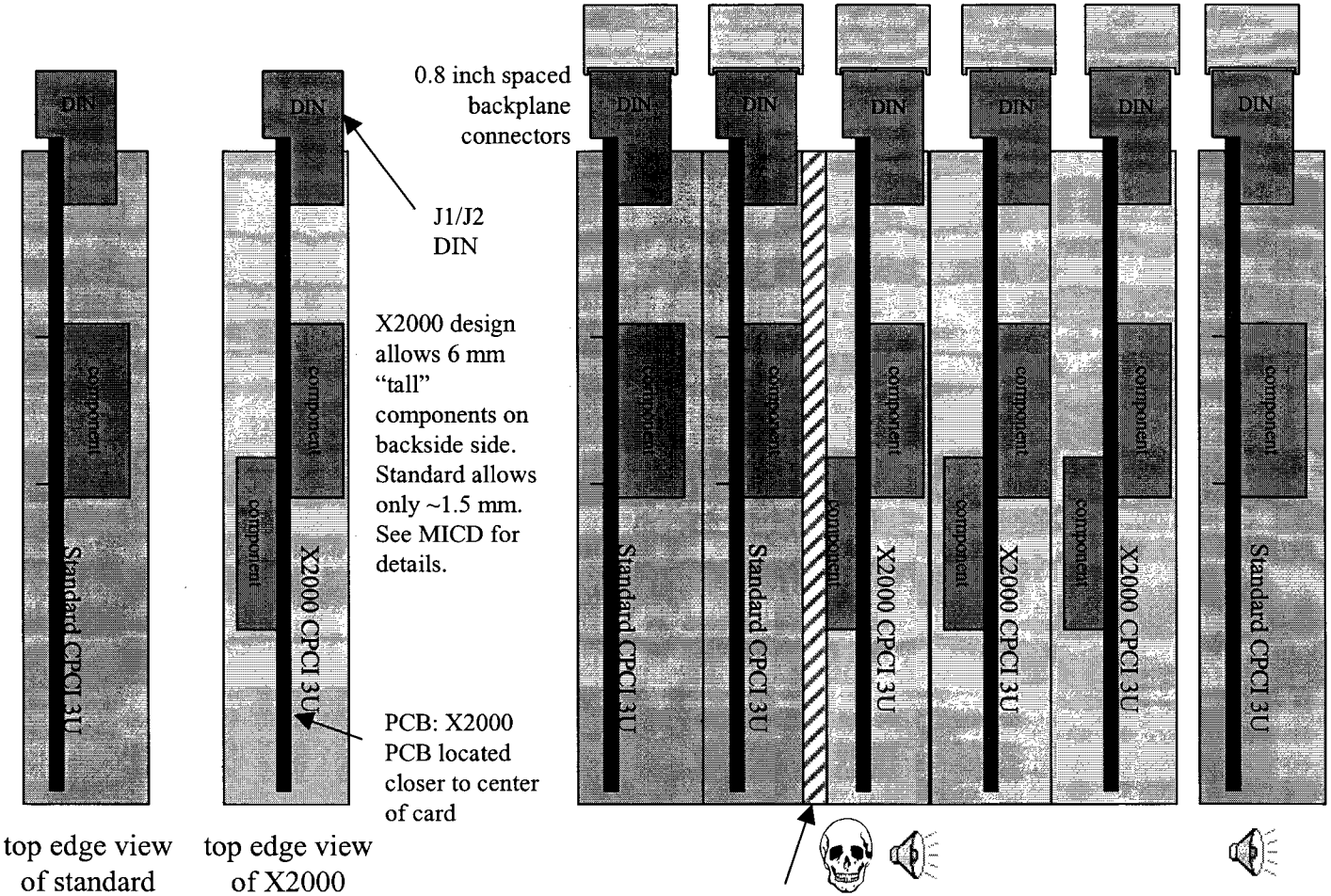
Connector Validation Test Table

Connector Type	REF	VIBRATION (1)	SHOCK (2)	THERMAL SOAK (3)	THERMAL CYCLING (4)	CURRENT RATING IN AIR	CURRENT RATING IN VACUUM	CURRENT RATING TRANSIENT
CPCI 110-pin w/ key	J1							
AMP		COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	EST. JUL-01	COMPLETED
ERNI		COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	EST. JUL-01	COMPLETED
LITTONWINCHESTER		COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	EST. JUL-01	COMPLETED
AVX/ELCO		-	-	-	-	COMPLETED	EST. JUL-01	COMPLETED
EPT		COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	-	-
CPCI 110-pin w/o key	J2							
AMP		COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	EST. JUL-01	COMPLETED
ERNI		COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	EST. JUL-01	COMPLETED
LITTONWINCHESTER		COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	EST. JUL-01	COMPLETED
AVX/ELCO		-	-	-	-	COMPLETED	EST. JUL-01	COMPLETED
EPT		COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	-	-
51-pin u-D (P)	J3	COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	-	-
100-pin u-D	J4	COMPLETED	COMPLETED	COMPLETED	COMPLETED	-	-	-
51-pin high density	J5	COMPLETED	COMPLETED		COMPLETED	-	-	-
96-pin high density	J5	COMPLETED	COMPLETED	-	COMPLETED	-	-	-
1394 4-pin custom	J6	COMPLETED	COMPLETED	-	COMPLETED	-	-	-
25-pin nano-D	J7	COMPLETED	COMPLETED	-	COMPLETED	-	-	-
21-pin u-D	J8	COMPLETED	COMPLETED	-	-	-	-	-
51-pin u-D (R)	J9	COMPLETED	COMPLETED	-	-	-	-	-

Updated on 1-26-00

Notes:
1- Vibration levels: .2 g2/Hz and .4 g2/Hz all three axis.
2- Shock: 2000 g all three axis.
3- Thermal Soak: 100 mate/demate then soak at 125C for 3000 hours
4- Thermal Cycling: 100 mate/demate then cycle at -55C to 125°C for 200 cycles.
5- (-) not required
6- (x) to be compled

Envelope Study



top edge view of standard CPCI card

top edge view of X2000 CPCI card

When a standard size card is placed left of an X2000 card, overlap will occur unless the standard card's front panel is removed and standard card's components do not impinge on X2000 backside components.

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Dynamic Test Chassis